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Working Party on Pollution and Energy (GRPE)
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agenda item 9.5.)

PROPOSAL FOR A DRAFT REGULATION

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF INTERNAL COMBUSTION ENGINES TO BE INSTALLED IN AGRICULTURAL AND FORESTRY TRACTORS AND IN NON-ROAD MOBILE MACHINERY WITH REGARD TO THE MEASUREMENT OF THE NET POWER

Transmitted by the Expert from Italy

Note: The text reproduced below was prepared by the expert from Italy following the consent given by WP.29 during its one-hundred-and-twenty-first session (TRANS/WP.29/735, paras. 78 and 79).

Note: This document is distributed to the Experts on Pollution and Energy only.

1. SCOPE

1.1. This Regulation applies to the determination of the engine power at full load curve as a function of engine speed, for the purpose of declaration by the manufacturer of internal combustion engines:

- used in category T vehicles 1/ [having an installed net power higher than 18 kW but not more than 560 kW],

- used in machinery intended and suited, to move, or to be moved on the ground, with or without road, [having an installed net power higher than 18 kW but not more than 560 kW when powered by a compression-ignition (C.I.) engine, and below 19 kW when powered by a positive-ignition engine] operated under intermittent or constant speed, including but not limited to:

  Industrial drilling rigs, compressors etc.

  Construction equipment including wheel loaders, bulldozers, crawler tractors, crawler loaders, truck-type loaders, off-highway trucks, hydraulic excavators etc.

  Agricultural equipment, rotary tillers

  Forestry equipment

  Self propelled agricultural vehicles

  Material handling equipment

  Fork-lift trucks

  Road maintenance equipment (motor graders, road rollers, asphalt finishers)

  Snow plough equipment

  Ground support equipment in airports

  Aerial lifts

  Mobile cranes

  Lawn mowers

  Chain saws

  Generators

  Water pumps

  Brush cutters

  Gas compressors

1/ As described in annex 7 of the Consolidated Resolution on the Construction of Vehicles (R.E.3.) (TRANS/WP.29/78/Rev.1/Amend. 2).

Generating sets with intermittent load including generating sets on board of ships, refrigerating units, welding sets

Turf care, chippers, snow removal equipment, sweepers

Irrigation pumps.

[1.2. This Regulation applies also to the check of both rated speed and power of engines, intended to function at constant speed, as indicated by the manufacturer.]

1.3. The internal combustion engines belong to one of the following categories:

Reciprocating internal combustion engines (positive-ignition or compression-ignition), but excluding free piston engines;

Rotary piston engines (positive-ignition or compression-ignition).

2. DEFINITIONS

2.1. "Approval of an engine" means the approval of an engine type with regard to its net power measured in accordance with the procedure specified in annex 4 to this Regulation;

2.2. "Approval of an engine family" means the approval of the members of an engine family with regard to their net power in accordance with the procedure specified in annexes 5 or 6 to this Regulation;

2.3. "Engine type" means a category of engines which do not differ in such essential engine characteristics as defined in annex 1 appendix 3;

2.4. "Engine family" means a manufacturer's grouping of engines which, through their design, fulfil the grouping criteria laid down in annex 5 to this Regulation;

2.5. "Parent engine" means an engine selected from an engine family in such a way that it complies with requirements set out in annex 5 of this Regulation;

2.6. "Net power" means the power obtained on a test bench at the end of the crankshaft or its equivalent at the corresponding engine speed with the auxiliaries and equipment listed in Table 1 of annex 4 to this Regulation, determined under reference atmospheric conditions;

2.7. "Rated net power" means engine net power as declared by the manufacturer at rated speed;

2.8. "Maximum net power" means the maximum value of the net power measured at full engine load;

2.9. "Rated speed" means the maximum full load speed allowed by the governor as specified by the manufacturer. This definition shall be modified to follow Regulation No. 96 when the rated speed will be defined according to CFR 40 Part 94.10; 2/

2/ Code of Federal Regulations of the United States of America.

2.10. "Maximum torque speed" means the engine speed at which the maximum torque is obtained, as specified by the manufacturer;

2.11. "Maximum torque" means the maximum value of the net torque measured at full engine load.

3. APPLICATION FOR APPROVAL

3.1. The application for approval of an engine type or an engine family with regard to the measurement of the net power shall be submitted by the manufacturer or by his duly accredited representative.

3.2. It shall be accompanied by the following documents in triplicate: description of the engine type or engine family comprising all the relevant particulars referred to in annex 1 to this Regulation.

3.3. An engine representative of the engine type to be approved, or the parent engine, in case of an engine family, fitted with the equipment prescribed in annex 4 to this Regulation, shall be submitted to the technical service conducting the approval tests.

4. APPROVAL

4.1. If the power of the engine submitted for approval pursuant to this Regulation was measured according to the specifications of paragraph 5 below, approval of the engine type or family shall be granted.

4.2. An approval number shall be assigned to each engine type or family approved. Its first two digits (at present 00 for the Regulation in its original form) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to another engine type or family.

4.3. Notice of approval or of extension or of refusal of approval of an engine type or an engine family pursuant to this Regulation shall be communicated to the Parties to the 1958 Agreement applying this Regulation by means of a form conforming to the model in annex 2 to this Regulation.

4.4. There shall be affixed, conspicuously and in a readily accessible place as specified on the approval form, to every engine conforming to an engine type or an engine family approved under this Regulation an international approval mark consisting of:

4.4.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval; 3/

4.4.2. The number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.

Alternatively, instead of affixing these approval marks and symbols to the engine, the manufacturer may decide that engine approved under this Regulation shall be accompanied by a document giving this information in order to enable the approval marks and symbol to be attached to the vehicle.

4.5. If the engine conforms to an approved type or family under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. need not be repeated; in such a case the Regulation and approval numbers and the additional symbols of all the Regulations under which approval has been granted under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.

4.6. The approval mark shall be placed close to or on the data plate affixed by the manufacturer to the approved type.

4.7. Annex 3 to this Regulation gives examples of arrangements of approval marks.

4.8. The engine approved as a technical unit must bear, in addition to the approval mark:

4.8.1. the trademark or trade name of the manufacturer of the engine;

4.8.2. the manufacturer’s engine code.

3/ 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech Republic, 9 for Spain, 10 for Yugoslavia, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal, 22 for the Russian Federation, 23 for Greece, 24 for Ireland, 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia and Herzegovina, 32 for Latvia, 33 (vacant), 34 for Bulgaria, 35-36 (vacant), 37 for Turkey, 38-39 (vacant), 40 for The former Yugoslav Republic of Macedonia, 41 (vacant), 42 for the European Community (Approvals are granted by its Member States using their respective ECE symbol), 43 for Japan, 44 (vacant), 45 for Australia and 46 for Ukraine. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

5. SPECIFICATIONS AND TESTS

5.1. General

The components liable to affect the power of the engine shall be so designed, constructed and assembled as to enable the engine in normal use, despite the vibrations to which it may be subjected, to comply with the provisions of this Regulation.

5.2. Description of tests for internal combustion engines

5.2.1. The net power test shall consist of a run at full throttle for positive-ignition engines and at fixed full-load fuel injection pump setting for compression-ignition engines, the engine being equipped as specified in Table 1 of annex 4 to this Regulation.

5.2.2. Measurements shall be taken at a sufficient number of engine speeds to define correctly the power curve between the lowest and the highest engine speeds recommended by the manufacturer. This range of speeds must include the rotational speeds at which the engine produces its maximum power and its maximum torque.

5.2.3. The fuel used shall be the following:

5.2.3.1. For positive-ignition engines fuelled with petrol:

The fuel used shall be the reference fuel specified in annex 7.

5.2.3.2. For positive-ignition engines fuelled with LPG:

5.2.3.2.1. In the case of an engine with self-adaptive fuelling:

The fuel used shall be the one available on the market. In any case of dispute the fuel shall be one of the reference fuels specified in annex 7;

5.2.3.2.2. In the case of an engine without self-adaptive fuelling:

The fuel used shall be the reference fuel specified in annex 7 with the lowest C3-content, or

5.2.3.2.3. In the case of an engine labelled for one specific fuel composition:

The fuel used shall be the fuel for which the engine is labelled.

5.2.3.2.4. The fuel used shall be specified in the test report.

5.2.3.3. For positive-ignition engines fuelled with natural gas:

5.2.3.3.1. In the case of an engine with self-adaptive fuelling:

The fuel used shall be the one available on the market. In any case of dispute the fuel shall be one of the references fuels specified in annex 7;

5.2.3.3.2. In the case of an engine without self-adaptive fuelling:

The fuel used shall be the one available on the market with the Wobbe Index at least 52.6 MJm-3 (20° C, 101.3 kPa). In case of dispute the fuel used shall be the reference fuel G20 specified in annex 7, i.e. the fuel with the highest Wobbe Index, or

5.2.3.3.3. In the case of an engine labelled for a specific range of fuels:

The fuel used shall be the one available on the market with the Wobbe Index at least 52.6 MJm^{-3} (20° C, 101.3 kPa) if the engine is labeled for the H-range of gases, or at least 47.2 MJm^{-3} (20° C, 101.3 kPa) if the engine is labelled for the L-range of gases. In case of dispute the fuel used shall be the reference fuel G20 specified in annex 7 if the engine is labeled for the H-range of gases, or the reference fuel G23 if the engine is labelled for the L-range of gases, i.e. the fuel with the highest Wobbe Index for the relevant range, or

5.2.3.3.4. In the case of an engine labelled for one specific fuel composition:

The fuel used shall be the fuel for which the engine is labelled.

5.2.3.3.5. The fuel used shall be specified in the test report.

5.2.3.4. For compression-ignition engines:

The fuel used shall be the reference fuel specified in annex 7

5.2.4. Measurements shall be carried out according to the provisions of annex 5 to this Regulation.

5.2.5. The test report shall contain the results and all the calculations required to determine the net power, as listed in the appendix to annex 4 to this Regulation together with the characteristics of the engine, as listed in annex 1 to this Regulation.

5.3. Interpretation of Results

5.3.1. Net Power

The net power declared by the manufacturer for the type of engine (or parent engine) shall be accepted if it does not differ by more than ± 2 per cent for maximum net power and more than ± 4 per cent at the other measurement points on the curve with a tolerance of ± 1.5 per cent for engine speed, from the values measured by the technical service on the engine submitted for testing.

5.3.2. Rated speed

The rated speed declared by the manufacturer shall not deviate by more than 100 min^{-1} from the declared value

5.3.3. Engine family

In case of compliance of the parent engine to the conditions in paragraphs 5.3.1 and 5.3.2, the acceptance is automatically extended to all the declared curves of the family members.

6. CONFORMITY OF PRODUCTION

The conformity of production procedures shall comply with those set out in the Agreement, appendix 2 (E/ECE/324-E/ECE/TRANS/505/Rev.2), with the following requirements:

6.1. Engines approved under this Regulation shall be so manufactured as to conform to the type approved.

6.2. The minimum requirements for conformity of production control procedures set forth in annex 6 to this Regulation shall be complied with.

7. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

7.1. The approval granted in respect of an engine type or an engine family pursuant to this Regulation may be withdrawn if the requirements set forth in paragraph 6.1. above are not met or if an engine or an engine family bearing the approval mark does not conform to the type approved.

7.2. If a Contracting Party to the 1958 Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in annex 2 to this Regulation.

8. MODIFICATION AND EXTENSION OF APPROVAL OF AN ENGINE TYPE OR ENGINE FAMILY

8.1. Every modification of an engine type or an engine family with regard to the characteristics in annex 1, shall be notified to the administrative department which approved the engine type or engine family. The department may then either:

8.1.1. Consider that the modifications made are unlikely to have any appreciable adverse effect and that in any case the engine still complies with the requirements; or

8.1.2. Require a further test report from the technical service responsible for conducting the tests.

8.2. Confirmation or refusal of approval, specifying the alterations shall be communicated by the procedure specified in paragraph 4.3. above to the Parties to the Agreement applying this Regulation.

8.3. The competent authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in annex 2 to this Regulation.

9. PRODUCTION DEFINITELY DISCONTINUED

If the holder of an approval completely ceases to manufacture an engine type or an engine family approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication that authority shall inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in annex 2 to this Regulation.

10. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS

The Parties to the Agreement which apply this Regulation shall communicate to the United Nations Secretariat the names and addresses of the technical services responsible for conducting approval tests, and/or the administrative departments which grant approval, and to which forms certifying approval or extension or refusal of approval, issued in other countries, are to be sent.

_____

Annex 1

ESSENTIAL CHARACTERISTICS OF THE INTERNAL COMBUSTION ENGINE
AND GENERAL INFORMATION CONCERNING THE CONDUCT OF TESTS

Parent engine/engine type 1/: .....

1. General

1.1. Make (name of undertaking): .....

1.2. Type and commercial description of the parent - and (if applicable) of the family engine(s) 1/: .....
.....

1.3. Manufacturer's type coding as marked on the engine(s) 1/: .....
.....

1.4. Specification of machinery to be propelled by the engine 2/: .....
.....

1.5. Name and address of manufacturer: .....
.....

1.6. Name and address of manufacturer's authorized representative (if any): .
.....

1.7. Location, coding and method of affixing of the engine identification:
.....

1.8. Location and method of affixing of the approval mark: .....
.....

1.9. Address(es) of assembly plant(s): .....
.....

2. Attachments

2.1. Essential characteristics of the parent engine(s) (see appendix 1) .....
.....

2.2. Essential characteristics of the engine family (see appendix 2) .....
.....

2.3. Essential characteristics of engine types within the family (see appendix 3) .....
.....

3. Characteristics of engine-related parts of the mobile machinery (if applicable) .....
.....

4. Photographs of the parent engine .....

5. List further attachments, if any .....

1/ Strike out what does not apply.
2/ List the types and models.

Annex 1 - Appendix 1

ESSENTIAL CHARACTERISTICS OF THE ENGINE / PARENT ENGINE 1/

1. DESCRIPTION OF ENGINE

1.1. Manufacturer: .....

1.1.2. Manufacturer's engine code: .....

1.1.3. Working principle: positive-ignition/compression-ignition, four-stroke/two-stroke 1/

1.4. Bore 3/: ..... mm

1.5. Stroke 3/: ..... mm

1.6. Number, layout and firing order of cylinders: .....

1.7. Engine capacity 4/: ..... cm^3

1.8. Rated speed: ..... min^{-1}

1.9. Maximum torque speed: ..... min^{-1}

1.10. Volumetric compression ratio 2/: .....

1.11. Combustion system description: .....

1.12. Drawing(s) of combustion chamber and piston crown: .....

1.13. Minimum cross-sectional area of inlet and outlet ports: .....

1.14. Cooling system: liquid/air 1/

1.14.1. Liquid

1.14.1.1. Nature of liquid: .....

1.14.1.2. Circulating pump(s): yes/no 1/

1.14.1.3. Characteristics or make(s) and type(s) (if applicable): .....
.....

1.14.1.4. Drive ratio(s) (if applicable): .....

1.14.2. Air

1.14.2.1. Blower: yes/no 1/

1.14.2.2. Characteristics or make(s) and type(s) (if applicable): .....
.....

1.14.2.3. Drive ratio(s) (if applicable): .....

1.15. Temperature permitted by the manufacturer

1.15.1. Liquid cooling: maximum temperature at outlet: .....K

1.15.2. Air cooling: reference point: .....

1.15.3. Maximum temperature at reference point: .....K

1.15.4. Maximum charge air outlet temperature at the inlet inter-cooler (if applicable): .....K

1.15.5. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): .....K

1.15.5. Lubricant temperature: minimum: .....K
maximum: .....K

1.16. Pressure charger: yes/no 1/

1.16.1. Make: .....

1.16.2. Type: .....

1.16.3. Description of the system (e.g. max. charge pressure, waste-gate, if applicable): .....

1.16.4. Inter-cooler: yes/no 1/

1.17. Intake system: maximum allowable intake depression at rated engine speed and at 100 % load: .....kPa

1.18. Exhaust system: maximum allowable exhaust back-pressure at rated engine speed and at 100 % load: .....kPa

2. ADDITIONAL ANTI-POLLUTION DEVICES (if any, and if not covered by and her heading)

2.1. Description and/or diagram(s): .....
.....

3. FUEL FEED FOR COMPRESSION-IGNITION ENGINES

3.1. Feed pump

3.1.1. Pressure or characteristic diagram 2/: .....kPa

3.2. Injection system

3.2.1. Pump

3.2.1.1. Make(s): .....

3.2.1.2. Type(s): .....

3.2.1.3. Maximum fuel delivery: ..... mm^3 1/ 2/ per stroke or cycle at full injection at pump speed of: ..... min^{-1} (rated) and ..... min^{-1} (maximum torque) respectively, or characteristic diagram: .....
.....

3.2.1.3.1. Mention the method used: on engine/on pump bench 1/

3.2.1.4. Injection advance

3.2.1.4.1. Injection advance curve 2/: .....

3.2.1.4.2. Timing 2/: .....

3.2.2. Injection piping

3.2.2.1. Length: ..... mm

3.2.2.2. Internal diameter: ..... mm

3.2.3. Injector(s)

3.2.3.1. Make(s): .....

3.2.3.2. Type(s): .....

3.2.3.3. Opening pressure or characteristic diagram 1/ 2/: ..... kPa

3.2.4. Governor

3.2.4.1. Make(s): .....

3.2.4.2. Type(s): .....

3.2.4.3. Speed at which cut-off starts under full load 2/: ..... min^{-1}

3.2.4.4. Maximum no-load speed 2/: ..... min^{-1}

3.2.4.5. Idling speed 2/: ..... min^{-1}

3.3. Cold start system

3.3.1. Make(s): .....

3.3.2. Type(s): .....

3.3.3. Description: .....

3.3.4 Electronic Engine Management Control Unit

3.3.4.1. Make(s): .....

3.3.4.2. Type: .....

3.3.4.3. Emission related adjustment possibilities: . .....,

3.3.4.4. Further documentation: .....

4. FUEL FEED FOR POSITIVE-IGNITION ENGINES

4.1. Carburettor

4.1.1. Make(s): .....

4.1.2. Type(s): .....

4.2. Port fuel injection: single-point or multi-point 1/

4.2.1. Make(s): .....

4.2.2. Type(s): .....

4.3. Direct-injection

4.3.1. Make(s): .....

4.3.2. Type(s): .....

4.4. Fuel flow [g/h] and air/fuel ratio at rated speed and wide open throttle: .....

4.5 Electronic Engine Management Control Unit: .....

4.5.1. Make(s): .....

4.5.2. Type: .....

4.5.3. Emission related adjustment possibilities: .....

4.5.4. Further documentation: .....

5. VALVE TIMING

5.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data: .....

5.2. Reference and/or setting ranges 1/: .....

5.3. Variable valve timing system (if applicable and where: intake and/or exhaust) 1/: .....

5.3.1. Type: continuous or on/off 1/

5.3.2. Cam phase shift angle: .....

6. PORTING CONFIGURATION

6.1. Position, size and number: .....

7. IGNITION SYSTEM

7.1. Ignition coil

7.1.1. Make(s): .....

7.1.2. Type(s): .....

7.1.3. Number: .....

7.2. Spark plug(s)

7.2.1. Make(s): .....

7.2.2. Type(s): .....

7.3. Magneto

7.3.1. Make(s): .....

7.3.2. Type(s): .....

7.4. Ignition timing

7.4.1. Static advance with respect to Top Dead Center [crank angle degrees] .....

7.4.2. Advance curve, if applicable .....

_____

_____

1/ Strike out what does not apply.

2/ Specify the tolerance.

3/ This value shall be rounded-off to the nearest tenth of a millimetre.

4/ This value shall be calculated with $\pi = 3.1416$ and rounded-off to the nearest cm^3.

Annex 1 - Appendix 2

ESSENTIAL CHARACTERISTICS OF THE ENGINE FAMILY

1. COMMON PARAMETERS 1/

1.1. Combustion cycle: .....

1.2. Cooling medium: .....

1.3. Method of air aspiration: .....

1.4. Combustion chamber type/design: .....
.....

1.5. Valve and porting 3/4 configuration, size and number: .....
.....

1.6. Fuel system: .....

1.7. Engine management systems

Proof of identity pursuant to drawing number(s): .....
.....

1.7.1. charge cooling system: .....

1.7.2. exhaust gas recirculation 2/: .....

1.7.3. water injection/emulsion 2/: .....

1.7.4. air injection 2/: .....

1.8. Exhaust after-treatment system 2/: .....
.....

Proof of identical (or lowest for the parent engine) ratio: system capacity/fuel delivery per stroke, pursuant to diagram number(s): .....
.....

2. ENGINE FAMILY LISTING

2.1. Name of engine family: .....

2.2. Specification of engines within this family: .....
.....
.....

Specification	Engines of the family				Parent engine 1/
Engine type					
No. of cylinders					
Rated speed (min^{-1})					
Fuel delivery per stroke (mm^3) for compression-ignition engines, fuel flow (g/h) for positive-ignition engines					
Rated net power (kW)					
Maximum torque speed (min^{-1})					
Fuel delivery per stroke (mm^3)					
Maximum torque (Nm)					
Low idle speed (min^{-1})					
Cylinder displacement (in % of parent engine)					100

1/ For full details see annex 1 – apendix 1.

2/ Give all pertinent technical data.

Annex 1 - Appendix 3

ESSENTIAL CHARACTERISTICS OF ENGINE TYPE WITHIN THE FAMILY 1/

1. DESCRIPTION OF THE ENGINE

1.1. Manufacturer: .....

1.2. Manufacturer's engine code: .....

1.3. Cycle: four-stroke / two-stroke 2/

1.4. Bore 4/: ..... mm

1.5. Stroke 4/: ..... mm

1.6. Number, layout and firing order of cylinders: .....

1.7. Engine capacity 5/: ..... cm^3

1.8. Rated speed: ..... min^{-1}

1.9. Maximum torque speed: ..... min^{-1}

1.10. Volumetric compression ratio 3/: .....

1.11. Combustion system description: .....

1.12. Drawing(s) of combustion chamber and piston crown: .....
.....

1.13. Minimum cross-sectional area of inlet and outlet ports: .....

1.14. Cooling system: liquid / air 2/

1.14.1. Liquid

1.14.1.1. Nature of liquid: .....

1.14.1.2. Circulating pump(s): yes/no 2/

1.14.1.3. Characteristics or make(s) and type(s) (if applicable): .....
.....

1.14.1.4. Drive ratio(s) (if applicable): .....

1.14.2. Air

1.14.2.1. Blower: yes/no 2/

1.14.2.2. Characteristics or make(s) and type(s) (if applicable): .....
.....

1.14.2.3. Drive ratio(s) (if applicable): .....

1.15. Temperature permitted by the manufacturer

1.15.1. Liquid cooling: maximum temperature at outlet: ..... K

1.15.2. Air cooling: reference point: .....
maximum temperature at reference point: ..... K

1.15.3. Maximum charge air outlet temperature at the inlet intercooler (if applicable): ..... K

1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): ..... K

1.15.5. Lubricant temperature: minimum ..... K
maximum ..... K

1.16. Pressure charger: yes/no 1/

1.16.1. Make: .....

1.16.2. Type: .....

1.16.3. Description of the system (e.g. max charge pressure, waste-gate, if applicable): .....

1.16.4. Inter-cooler: yes/no 1/

1.17. Intake system: maximum allowable intake depression at rated engine speed and at 100 % load: ..... kPa

1.18. Exhaust system: maximum allowable exhaust back-pressure at rated engine speed and at 100 % load: ..... kPa

2. ADDITIONAL ANTI-POLLUTION DEVICES (if any, and if not covered by another heading)

Description and/or diagram(s): .....
.....

3. FUEL FEED FOR COMPRESSION-IGNITION ENGINES

3.1. Feed pump

Pressure 2/ or characteristic diagram: ..... kPa

3.2. Injection system

3.2.1. Pump

3.2.1.1. Make(s): .....

3.2.1.2. Type(s): .....

3.2.1.3. Maximum fuel delivery: ..... mm^3 2/ 3/ per stroke or cycle at full injection at pump speed of: ..... min^{-1} (rated) and ..... min^{-1} (maximum torque) respectively, or characteristic diagram: .....
.....

3.2.1.3.1. Mention the method used: on engine/on pump bench 1/

3.2.1.4. Injection advance

3.2.1.4.1. Injection advance curve 3/: .....

3.2.1.4.2. Timing 3/: .....

3.2.2. Injection piping

3.2.2.1. Length: .....mm

3.2.2.2. Internal diameter: .....mm

3.2.3. Injector(s)

3.2.3.1. Make(s): .....

3.2.3.2. Type(s): .....

3.2.3.3. Opening pressure or characteristic diagram 2/ 3/: .....kPa

3 2.4. Governor

3.2.4.1. Make(s): .....

3.2.4.2. Type(s): .....

3.2.4.3. Speed at which cut-off starts under full load 3/: .....min^{-1}

3.2.4.4. Maximum no-load speed 3/: .....min^{-1}

3.2.4.5. Idling speed 3/: .....min^{-1}

3.3. Cold start system

3.3.1. Make(s): .....

3.3.2. Type(s): .....

3.3.3. Description: .....

3.4 Electronic Engine Management Control Unit:

3.4.1. Make(s): .....

3.4.2. Type: .....

3.4.3. Emission related adjustment possibilities: . .....,

3.4.4. Further documentation: .....

4. FUEL FEED FOR POSITIVE-IGNITION ENGINES

4.1. Carburettor

4.1.1. Make(s): .....

4.1.2. Type(s): .....

4.2. Port fuel injection: single-point or multi-point 2/

4.2.1. Make(s): .....

4.2.2. Type(s): .....

4.3. Direct-injection

4.3.1. Make(s): .....

4.3.2. Type(s): .....

4.4. Fuel flow [g/h] and air/fuel ratio at rated speed and wide open throttle

4.5. Electronic engine management control unit

4.5.1. Make(s): .....

4.5.2. Type: .....

4.5.3. Emission related adjustment possibilities: . .....,

4.5.4. Further documentation: .....

5. VALVE TIMING

5.1. Maximum lift and angles of opening and closing in relation to dead centers or equivalent data: .....

5.2. Reference and/or setting range 2/: .....

5.3. Variable valve timing system (if applicable and where: intake and/or exhaust) 2/: .....

5.3.1. Type: continuous or on/off 2/

5.3.2. Cam phase shift angle: .....

6. PORTING CONFIGURATION

6.1. Position, size and number: .....

7. IGNITION SYSTEM

7.1. Ignition coil

7.1.1. Make(s): .....

7.1.2. Type(s): .....

7.1.3. Number

7.2. Spark plug(s)

7.2.1. Make(s): .....

7.2.2. Type(s): .....

7.3. Magneto

7.3.1. Make(s): .....

7.3.2. Type(s): .....

7.4. Ignition timing

7.4.1. Static advance with respect to Top Dead Center [crank angle degrees]: .....

7.4.2. Advance curve, if applicable: .....

_____

_____

1/ For full details see annex 1 – appendix 1.

2/ Strike out what does not apply.

3/ Specify the tolerance.

4/ This value shall be rounded-off to the nearest tenth of a millimetre.

5/ This value shall be calculated with $\pi = 3.1416$ and rounded-off to the nearest cm^3.

Annex 2

(Maximum format: A4 (210 x 297 mm))

COMMUNICATION

issued by: Name of administration:
.....
.....
.....

concerning 2/: APPROVAL GRANTED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITIVELY DISCONTINUED
of an engine or an engine family pursuant to Regulation No. XXX.

Approval No. ..... Extension No. .....

1. Trade name or mark of engine: .....

2. Manufacturer's designation of the parent and (if applicable) of the family engine(s) type(s) 2/ .....
.....

3. Manufacturer's type coding as marked on the engine(s): .....

3.1. Location: .....

3.2. Method of affixing: .....

4. Name and address of manufacturer: .....

4.1. Name and address of manufacturer's authorized representative (if any): .....
.....

5. Location, coding and method of affixing of the engine identification number: .....

6. Technical service responsible for conducting approval tests: .....
.....
.....

7. Date of report issued by that service: .....

8. Number of report issued by that service: .....

9. Location and method of affixing of the ECE approval mark: .....

10. Reason(s) for extension of approval (if applicable): .....
.....

11. Main specification of internal combustion engine

11.1. Declared data

11.1.1. Rated net power: ..... kW, at ..... min^{-1}

11.1.2. Maximum net power: ..... kW, at ..... min^{-1}

11.1.3. Maximum net torque: ..... Nm, at ..... min^{-1}

11.1.3 Rated speed: ..... min^{-1} Rated net power: ..... kW

11.2. Essential characteristics of the engine type/parent engine type: .....

.....

11.2.1. Operating principle:

11.2.1.1. Positive-ignition/compression-ignition 2/

11.2.1.2. four-stroke/two-stroke 2/

11.2.2. Number, layout and firing order of cylinders: .....

11.2.3. Cylinder capacity: ..... cm^3

11.2.4. Fuel feed: carburettor/indirect injection/direct injection 2/

11.2.3. Pressure-charger device: Yes/No 2/

11.2.4. Exhaust after-treatment device: Yes/No 2/

11.3. Engine fuel requirements: leaded petrol / unleaded petrol / diesel fuel / NG / LPG: 2/

11.4. Restriction of use:

11.4.1. Particular conditions to be respected in the installation of the engine(s) on the machinery

11.4.1.1. Maximum allowable intake depression: ..... kPa

11.4.1.2. Maximum allowable back-pressure: ..... kPa

11.4.2. Any other (if applicable): .....

12. Main family members specifications:

Specification	Engines of the family				Parent engine
Manufacturer's type coding					
No of cylinders					
Engine capacity (cm^3)					
Rated net power (kW)					
Rated speed (min^{-1})					
Maximum net power (kW)					
Max. net power speed (min^{-1})					
Max. net torque (Nm)					
Max. net torque speed (min^{-1})					
Low idle speed (min^{-1})					
Restrictions of use [Yes/No]					

13. Approval granted/extended/refused/withdrawn 2/

14. Place: .....

15. Date: .....

16. Signature: .....

17. The documents filed with the request for approval or extension may be obtained on request.

_____

1/ Distinguishing number of the country which has granted/extended/refused/ withdrawn approval (see approval provisions in the Regulation).

2/ Strike out what does not apply.

Annex 3

ARRANGEMENTS OF APPROVAL MARKS

Model A

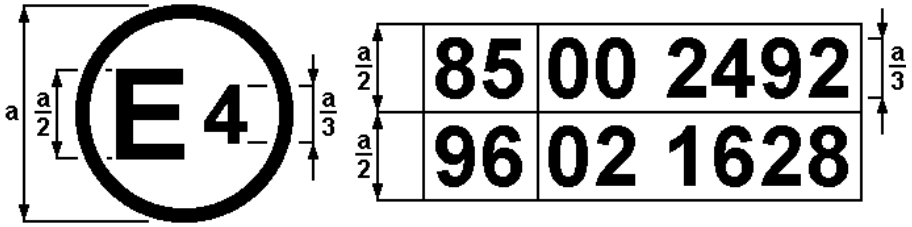
(see paragraph 4.4. of this Regulation)

a = 8 mm min.

The above approval mark affixed to an engine shows that the engine type concerned has been approved in the Netherlands (E 4) with regard to the measurement of the net power, pursuant to Regulation No. XX and under the approval number 002492. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No. XX in its original form.

Model B

(see paragraph 4.5. of this Regulation)



a = 8 mm min.

The above approval mark affixed to an engine shows that the engine type concerned has been approved in the Netherlands (E 4) pursuant to Regulations No. XX and 96 3/. The first two digits of the approval numbers indicate that, at the dates when the respective approvals were granted, Regulation No. XX had not been modified, and Regulation No. 96 already included the 02 series of amendments.

_____

3/ The second number is given merely as an example.

Annex 4

METHOD FOR MEASURING INTERNAL COMBUSTION ENGINE NET POWER

1. These provisions apply to the method for determining the power curve at full load of an internal combustion engine as a function of engine speed.

2. TEST CONDITIONS

2.1. The engine shall have been run-in according to the manufacturer's recommendations.

2.2. If the power measurement can be carried out only on an engine with the gearbox mounted, the efficiency of the gearbox shall be taken into account.

2.3. Auxiliaries and equipment

2.3.1. Auxiliaries and equipment to be fitted

During the test, the auxiliaries necessary for the engine operation in the intended application (as listed in Table 1) shall be installed on the test bench as far as possible in the same position as in the intended application.

2.3.2. Auxiliaries and equipment to be removed

Certain accessories whose definition is linked with the operation of the machine and which may be mounted on the engine shall be removed for the test. The following non-exhaustive list is given as a sample:

(i) air compressor for brakes

(ii) power steering compressor

(iii) suspension compressor

(iv) air-conditioning system

Where accessories cannot be removed, the power they absorb in the unloaded condition may be determined and added to the measured engine power (see note h of Table 1). If this value is greater than 3 per cent of the maximum power at the test speed it may verified by the test authority.

Table 1

EQUIPMENT AND AUXILIARIES TO BE INSTALLED
FOR THE TEST TO DETERMINE ENGINE POWER

Number	Equipment and auxiliaries	Fitted for emission test
1	Inlet system	
	Inlet manifold	Yes, standard production equipment.
	Crankcase emission control system	Yes, standard production equipment.
	Control devices for dual induction inlet manifold system	Yes, standard production equipment.
	Air flow meter	Yes, standard production equipment.
	Air inlet duct work	Yes. a/
	Air filter	Yes. a/
	Inlet silencer	Yes. a/
	Speed-limiting device	Yes. a/
2	Induction-heating device of inlet manifold	Yes, standard production equipment. If possible to be set in the most favourable condition.
3	Exhaust system	
	Exhaust purifier	Yes, standard production equipment.
	Exhaust manifold	Yes, standard production equipment.
	Connecting pipes	Yes. b/
	Silencer	Yes. b/
	Tail pipe	Yes. b/
	Exhaust brake	No. c/
	Pressure charging device	Yes, standard production equipment.
4	Fuel supply pump	Yes, standard production equipment. d/
5	Carburation equipment	
	Carburettor	Yes, standard production equipment.
	Electronic control system, air flow meter, etc.	Yes, standard production equipment.
	Equipment for gas engines	
	Pressure reducer	Yes, standard production equipment.
	Evaporator	Yes, standard production equipment.
	Mixer	Yes, standard production equipment.
6	Fuel injection equipment (petrol and diesel)	
	Pre-filter	Yes, standard production or test bed equipment.
	Filter	Yes, standard production or test bed equipment.
	Pump	Yes, standard production equipment.
	High-pressure pipe	Yes, standard production equipment.
	Injector	Yes, standard production equipment.
	Air inlet valve	Yes, standard production equipment. e/
	Electronic control system, air flow meter, etc.	Yes, standard production equipment.
	Governor/control system	Yes, standard production equipment.
	Automatic full-load stop for the control rack depending on atmospheric conditions	Yes, standard production equipment.

Number	Equipment and auxiliaries	Fitted for emission test
7	Liquid-cooling equipment	
	Radiator	No.
	Fan	No.
	Fan cowl	No.
	Water pump	Yes, standard production equipment. f/
	Thermostat	Yes, standard production equipment. g/
8	Air cooling	
	Cowl	No. h/
	Fan or Blower	No. h/
	Temperature-regulating device	No.
9	Electrical equipment	
	Generator	Yes, standard production equipment. i/
	Spark distribution system	Yes, standard production equipment.
	Coil or coils	Yes, standard production equipment.
	Wiring	Yes, standard production equipment.
	Spark plugs	Yes, standard production equipment.
	Electronic control system including knock sensor/spark retard system	Yes, standard production equipment.
10	Pressure charging equipment	
	Compressor driven either directly by the engine and/or by the exhaust gases	Yes, standard production equipment.
	Charge air cooler	Yes, standard production or test bed equipment. h/, k/
	Coolant pump or fan (engine-driven)	No. h/
	Coolant flow control device	Yes, standard production equipment.
11	Auxiliary test-bed fan	Yes, if necessary.
12	Anti-pollution device	Yes, standard production equipment. l/
13	Starting equipment	Test bed equipment. m/
14	Lubricating oil pump	Yes, standard production equipment.

a/ The complete inlet system shall be fitted as provided for the intended application:

(i) where there is a risk of an appreciable effect on the engine power;

(ii) in the case of naturally aspirated spark ignition engines;

(iii) when the manufacturer requests that this should be done.

In other cases, an equivalent system may be used and a check should be made to ascertain that the intake pressure does not differ by more than 100 Pa from the upper limit specified by the manufacturer for a clean air filter.

b/ The compete exhaust system shall be fitted as provided for the intended application:

(i) where there is a risk of an appreciable effect on the engine power;

(ii) in the case of naturally aspirated spark ignition engines;

(iii) when the manufacturer requests that this should be done.

In other cases, an equivalent system may be installed provided the pressure measured does not differ by more than 1,000 Pa from the upper limit specified by the manufacturer.

c/ If an exhaust brake is incorporated in the engine, the throttle valve shall be fixed in the fully open position.

d/ The fuel feed pressure may be adjusted, if necessary, to reproduce the pressure existing in the particular engine application (particularly when a "fuel return" system is used).

e/ The air intake valve is the control valve for the pneumatic governor of the injection pump. The governor or the fuel injection equipment may contain other devices which may affect the amount of injected fuel.

f/ The cooling-liquid circulation shall be operated by the engine water pump only. Cooling of the liquid may be produced by an external circuit, such that the pressure loss of this circuit and the pressure at the pump inlet remain substantially the same as those of the engine cooling system.

g/ The thermostat may be fixed in the fully open position.

h/ When the cooling fan or blower is fitted for the test, the power absorbed shall be added to the results, except for engines where such auxiliaries are an integral part of the engine (i.e.: cooling fans of air cooled engines directly fitted on the crankshaft). The fan or blower power shall be determined at the speeds used for the test either by calculation from standard characteristics or by practical tests.

i/ Minimum power of the generator: the electrical power of the generator shall be limited to that necessary for operation of accessories which are indispensable for engine operation. If the connection of a battery is necessary, a fully charged battery in good condition shall be used.

k/ Charge air-cooled engines shall be tested with charge air cooling, whether liquid - or air-cooled, but if the manufacturer prefers, a test bench system may replace the air cooler. In either case, the measurement of power at each speed shall be made with the maximum pressure drop and the minimum temperature drop of the engine air across the charge air cooler on the test bench system as those specified by the manufacturer.

l/ These may include, for example, exhaust-gas recirculation (EGR system */), catalytic converter, thermal reactor, secondary air-supply system and fuel evaporation protecting system.

m/ The power for electrical or other starting systems shall be provided from the test bed.

---

*/ exhaust gas recirculation.

2.4. Setting Conditions

The setting conditions for the test to determine the net power are indicated in Table 2.

Table 2

SETTING CONDITIONS

1. Setting of carburettor(s)	In accordance with the manufacturer's production specifications and used without further alteration for the particular application.
2. Setting of injection pump delivery system	
3. Ignition or injection timing (timing curve)	
4. Governor setting	
5. Emission control devices	
6. Boost Control	

3. DATA TO BE RECORDED

3.1. Data to be recorded are those indicated in paragraph 4 of the appendix to this annex. Performance data shall be obtained under stabilised operating conditions with an adequate fresh air supply to the engine. Combustion chambers may contain deposits, but in limited quantity. Test conditions, such as inlet air temperature, shall be selected as near to reference conditions (see paragraph 5.2. of this annex) as possible in order to minimise the magnitude of the correction factor.

3.2. The temperature of the inlet air to the engine shall be measured within the inlet ductwork. The inlet depression measurement shall be made at the same point. The thermometer or thermocouple shall be shielded from fuel spray-back and radiant heat and located directly in the air stream. A sufficient number of locations shall be used to give a representative average of the inlet temperature.

3.3. The inlet depression shall be measured downstream of the entry ducts, air filter, inlet silencer or speed-limiting device (if fitted).

3.4. The absolute pressure at the entry to the engine downstream of the compressor and heat exchanger, if fitted, shall be measured in the inlet manifold and at any other point where pressure has to be measured to calculate correction factors.

3.5. The exhaust back pressure shall be measured at a point at least three pipe diameters downstream from the outlet flange(s) of the exhaust manifold(s) and downstream at the turbocharger(s), if fitted. The location shall be specified.

3.6. No data shall be taken until torque, speed and temperatures have been maintained substantially constant for at least one minute.

3.7. The engine speed during a run or reading shall not deviate from the selected speed by more than ± 1 per cent or ± 10 min, whichever is greater.

3.8. Observed brake load, fuel consumption and inlet air temperature data shall be taken simultaneously and shall be the average of two stabilised consecutive values which do not vary more than 2 per cent for the brake load.

3.9. The temperature of the coolant at the outlet from the engine shall be kept at the value specified by the manufacturer.
If no temperature is specified by the manufacturer, the temperature shall be 353 K ± 5 K. For air-cooled engines, the temperature at a point indicated by the manufacturer shall be kept within +0/-20 K of the maximum value specified by the manufacturer in the reference conditions.

3.10. For C.I. engines, the fuel temperature shall be measured at the inlet of the fuel injection pump and maintained within 306 – 316 K (33-43° C) for positive-ignition engines the fuel temperature shall be measured as near as possible to the inlet of the carburettor or assemby of fuel injectors and maintained within 293 – 303 K (20-30° C).

3.11. The temperature of the lubricating oil measured in the oil pump or at the outlet from the coil cooler, if fitted, shall be maintained within the limits established by the engine manufacturer.

3.12. An auxiliary regulating system may be used if necessary to maintain the temperatures within the limits specified in paragraphs 3.9, 3.10. and 3.11. above of this annex.

4. ACCURACY OF MEASUREMENTS

4.1. Torque: ± 1 per cent of measured torque. The torque measuring system shall be calibrated to take friction losses into account. The accuracy in the lower half of the measuring range of the dynamometer bench may be ± 2 per cent of measured torque.

4.2. Engine speed: 0.5 per cent of measured speed.

4.3. Fuel consumption: ± 1 per cent of measured consumption.

4.4. Fuel temperature: ± 2 K.

4.5. Engine inlet air temperature: ± 2 K.

4.6. Barometric pressure: ± 100 Pa.

4.7. Depression in inlet system: ± 50 Pa.

4.8. Back-pressure in exhaust system: ± 200 Pa.

5. POWER CORRECTION FACTORS

5.1. Definition

The power correction factor is the coefficient to determine the engine power under the reference atmospheric conditions specified in 5.2. below.

$$P_o = á\ P$$

where

P_o is the corrected power (i.e. power under reference atmospheric conditions)

á is the correction factor ($á_a$ or $á_d$)

P is the measured power (test power)

5.2. Reference atmospheric conditions

5.2.1. Temperature (T_o): 298 K (25° C)

5.2.2. Dry pressure (P_{so}): 99 kPa

The dry pressure is based on a total pressure of 100 kPa and a water vapour pressure of 1 kPa.

5.3. Test atmospheric conditions

The atmospheric conditions during the test shall be the following:

5.3.1. Temperature (T)

For positive-ignition engines: $288\ K \leq T \leq 308\ K$
For compression-ignition engines: $283\ K \leq T \leq 313\ K$

5.3.2. Pressure (p_s)

$$90\ kPa < p_s < 110\ kPa$$

5.4. Determination of correction factor $á_a$ and $á_d$ 1/

5.4.1. Naturally aspirated or pressure-charged positive-ignition engine

The correction factor $á_a$ is obtained by applying the formula:

$$a_a = \left(\frac{99}{p_s}\right)^{1.2} * \left(\frac{T}{298}\right)^{0.6}$$

where

p_s is the total dry atmospheric pressure in kilopascals (kPa); i.e. the total barometric pressure minus water vapour pressure,

T is the absolute temperature in kelvins (K) of the air drawn in by the engine.

1/ The tests may be carried out in air-conditioned test rooms where the atmospheric conditions may be controlled.

In the case of engines fitted with automatic air temperature control, if the device is such that at full load at 25 °C no heated air is added, the test shall be carried out with the device fully closed. If the device is still operating at 25 °C then the test is made with the device operating normally and the exponent of the temperature term in the correction factor shall be taken as zero (no temperature correction).

Conditions to be complied with in the laboratory

For a test to be valid, the correction factor as must be such that

$$0.96 \leq á_a \leq 1.06$$

If these limits are exceeded, the corrected value obtained shall be given and the test conditions (temperature and pressure) precisely stated in the test report.

5.4.2. Compression-ignition engines - factor $á_d$

The power correction factor ($á_d$) for compression-ignition engines at constant fuel rate is obtained by applying the formula:

$$á_d = (f_a)\ f_m$$

where:
f_a is the atmospheric factor

f_m the characteristic parameter for each type of engine and adjustment

5.4.2.1. Atmospheric factor f_a

This factor indicates the effects of environmental conditions (pressure, temperature and humidity) on the air drawn in by the engine. The atmospheric factor formula differs according to the type of engine.

5.4.2.1.1. Naturally aspirated and mechanically pressure charged engines

$$f_a = \left(\frac{99}{p_s}\right) * \left(\frac{T}{298}\right)^{0.7}$$

5.4.2.1.2. Turbocharged engines without charge air cooling or with charge air cooling by air to air charge air cooler

$$f_a = \left(\frac{99}{p_s}\right)^{0.7} * \left(\frac{T}{298}\right)^{1.5}$$

5.4.2.1.3 Turbocharged engines with charge air cooling by air to liquid charge air cooler

5.4.2.2. Engine factor f_m

f_m is a function of q_c (fuel flow corrected) as follows:

$$f_m = 0.036\ q_c - 1.14$$

and

$$q_c = q/r$$

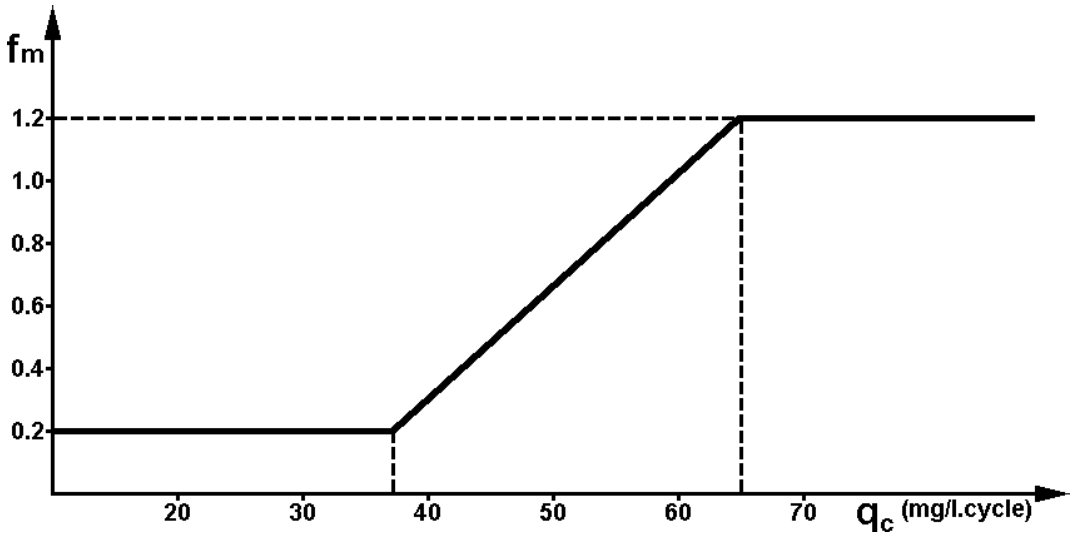
where:
q is the fuel flow in milligram per cycle per litre of total swept volume (mg/(l.cycle))

r is the pressure ratio of compressor outlet and compressor inlet (r = 1 for naturally aspirated engines)

This formula is valid for a value interval of q_c included between 37.2 mg/(l.cycle) and 65 mg/(l.cycle).

For q_c values lower than 37.2 mg/(l.cycle), a constant value of f_m equal to 0.2 (f_m = 0.2) will be taken.

For q_c values higher than 65 mg/(l.cycle), a constant value of f_m equal to 1.2 (f_m = 1.2) will be taken (see figure):



5.4.2.3. Conditions to be complied with in the laboratory

For a test to be valid; the correction factors $á_a$ must be such that

$$0.96 \leq á_a \leq 1.06$$

If these limits are exceeded, the corrected value obtained shall be given and the test conditions (temperature and pressure) precisely stated in the test report.

_____

Annex 4 - Appendix

RESULTS OF TESTS FOR MEASURING NET ENGINE POWER

This form shall be completed by the laboratory performing the test.

1. TEST CONDITIONS

1.1. Pressures measured at declared rated speed

1.1.1. Total barometric pressure: ..... Pa

1.1.2. Water vapour pressure: ..... Pa

1.1.3. Exhaust back-pressure: ..... Pa

1.1.4 Location of exhaust back-pressure measuring point

1.1.5 Inlet depression ..... Pa

1.1.6 Absolute pressure in the inlet manifold: ..... Pa

1.2. Temperatures measured at declared rated speed

1.2.1. of the intake air: ..... K

1.2.2. at the engine charge air cooler outlet: ..... K

1.2.3. of the cooling fluid: .....

1.2.3.1. at the engine cooling fluid outlet 1/: ..... K

1.2.3.2. at the reference point in the case of air cooling 1/: ..... K

1.2.4. of the lubricating oil: ... K (indicate point of measurement) .....
.....

1.2.5. of the fuel: ..... K

1.2.5.1. at the fuel carburettor inlet/fuel injection systems inlet 1/: ..... K

1.2.5.2. in the fuel flow measuring device: ..... K

1.3. Characteristics of the dynamometer

1.3.1. Make: ..... Model: .....

1.3.2 Type: .....

2. FUEL

2.1. For positive-ignition engines operating on liquid fuel

2.1.1. Make: .....

2.1.2. Specification: .....

2.1.3. Anti-knock additive (lead, etc): .....

2.1.3.1. Type: .....

2.1.3.2. Content: ..... mg/l

2.1.4. Octane number RON: ..... (ASTM D 26 99-70)

2.1.4.1. Specify density: ..... g/cm^3 at 288 K

2.1.4.2. Lower calorific value: ..... kJ/kg

2.2. For positive-ignition engines operating on gaseous fuel

2.2.1. Make: .....

2.2.2. Specification: .....

2.2.3. Storage pressure: ..... bar

2.2.4. Utilization pressure: ..... bar

2.2.5. Lower calorific value: ..... kJ/kg

2.3. For compression-ignition engines operating on gaseous fuels

2.3.1. Feed system: gas

2.3.2. Specification of gas used: .....

2.3.3. Fuel oil/gas proportion: .....

2.3.4. Lower calorific value: .....

2.4. For compression-ignition engines operating on liquid fuel

2.4.1. Make: .....

2.4.2. Specification of fuel used: .....

2.4.3. Cetane number (ASTM D 976-71): .....

2.4.4. Specify density: ..... g/cm^3 at 288 K

2.4.5. Lower calorific value: ..... kJ/kg

3. LUBRICANT

3.1. Make: .....

3.2. Specification: .....

3.3. SAE viscosity: .....

4. Detailed results of measurements */

Engine speed, min^{-1}		
Measured torque, Nm		
Measured power, kW		
Measured fuel flow, g/h		
Barometric pressure, kPa		
Water vapour pressure, kPa		
Inlet air temperature, K		
Power to be added for No. 1 auxiliaries and equipment in excess No. 2 of Table 1, kW No. 3		
Power correction factor		
Corrected brake power, kW		
Net power, kW		
Net torque, Nm		
Corrected specific fuel consumption g/(kWh) 2/		
Cooling liquid temperature at outlet, K		
Lubricating oil temperature at measuring point, K		
Air temperature after pressure-charger, K 1/		
Fuel temperature at injection pump inlet, K		
Air temperature after charge air cooler, K 1/		
Pressure after pressure-charger, kPa		
Pressure after charge air cooler, kPa		
Inlet depression, Pa		
Exhaust back-pressure, Pa		
Fuel delivery, mm^3/stroke or cycle 1/		

*/ The characteristic curves of the net power and the net torque shall be drawn as a function of the engine speed.

1/ Strike out what does not apply.

2/ Calculated with the net power for compression-ignition and positive-ignition engines, in the latter case multiplied by the power correction factor.

Annex 5

PARAMETERS DEFINING THE ENGINE FAMILY

The engine family may be defined by basic design parameters which must be common to engines within the family. In some cases there may be interaction of parameters. These effect must also be taken into consideration to ensure that only engines with similar exhaust emission characteristics are included within an engine family.

In order that engines be considered to belong to the same engine family, the following list of basic parameters must be common:

6.1. Combustion cycle

four-stroke
two-stroke

6.2. Cooling medium:

air
water
oil

6.3. Individual cylinder displacement

engines to be within a total spread of 15 per cent (alternatively individual cylinder displacement, within 85 % and 100 % of the largest displacement within the engine family. (NOTE: ISO 8178 Part 7))

number of cylinders for engines with after-treatment device

6.4. Method of air aspiration

naturally aspirated
pressure-charged

6.5 Fuel type

diesel
petrol
gaseous fuel (NG or LPG)

6.6. Combustion chamber type/design

pre-chamber
swirl chamber
open chamber

6.7. Valve and porting 3/4 configuration, size and number

cylinder head
cylinder wall
crankcase

6.7. Fuel system

6.7.1. For compression-ignition engines

pump-line-injector
in-line pump
distributor pump
single element
unit injector

6.7.1. For positive-ignition engines

carburettor
port fuel injection
direct injection

6.8. Miscellaneous features

exhaust gas recirculation
water injection(emulsion)
air injection
charge cooling system

6.9. Exhaust after-treatment

oxidation catalyst
reduction catalyst
thermal reactor
particulate trap

7. CHOICE OF THE PARENT ENGINE

7.1. The parent engine of the family shall be selected using the primary criteria of the highest fuel delivery per stroke at the declared maximum torque speed.

In the event that two or more engines share this primary criteria, the parent engine be selected using the secondary criteria of highest fuel delivery per stroke at rated speed. Under certain circumstances, the approval authority may conclude that the worst case emission rate of the family can best be characterized by testing a second engine. Thus, the approval authority may select an additional engine for test based upon features which indicate that it may have the highest emission levels of the engines wit in that family.

7.2. If engines within the family incorporate other variable features which could be considered to affect exhaust emissions, these features must also be identified and taken into account in the selection of the parent engine.

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Annex 6

CHECKS ON CONFORMITY OF PRODUCTION

1. GENERAL

These requirements are consistent with tests to be held to check conformity of production, according to paragraph 6.2.

2. TEST PROCEDURES

The methods of testing and measuring instruments shall be those described in annexes 5 or 6 to this Regulation.

3. COLLECTION OF SAMPLES

One engine has to be chosen. If after the test of paragraph 5.1. below, the engine is not considered as conforming to the requirements of this Regulation, two more engines have to be tested. In case the engine belongs to an approved engine family, the two more engines shall be of the same member type.

4. MEASUREMENT CRITERIA

4.1. Net power of internal combustion engine

During the tests to verify conformity of production, the power shall be measured at two engine speeds S1 and S2 corresponding respectively to the measurement points of rated power and maximum torque accepted for type approval. At these two engine speeds, which are subject to a tolerance of ± 5 per cent, the net power measured at least one point within the ranges S1 ± 5 per cent and S2 ± 5 per cent shall not differ by more than ± 5 per cent from the approval figure.

5. EVALUATION OF RESULTS

If the net power figures of the second and/or third engine of paragraph 3. does not fulfil the requirements of paragraph 4. above, the production shall be considered not to conform to the requirements of this Regulation and the provision of paragraph 7. shall be put into effect.

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Annex 7

TECHNICAL DATA OF REFERENCE FUELS

1. Technical data of the LPG reference fuels

		Fuel A	Fuel B	Test method
Composition:	Units:			ISO 7941
C3	% Vol.	30 ± 2	85 ± 2	
C4	% Vol.	balance	balance	
<C3, >C4	% Vol.	max. 2%	max. 2%	
Olefines	% Vol.	9 ± 3	12 ± 3	
Evaporative residue	ppm	max. 50	max. 50	NFM 41-015
Water content		none	none	visual inspect.
Sulphur content	ppm mass 1/	max. 50	max. 50	EN 24260
Hydrogen sulphide		none	none	
Copper corrosion	rating	class 1	class 1	IS06251 2/
Odour		characteristic	characteristic	
MON		min. 89	min. 89	EN 589 annex B

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1/ value to be determined at standard conditions (293.2 K (20 °C) and 101.3 kPa).

2/ This method may not accurately determine the presence of corrosive materials if the sample contains corrosion inhibitors or other chemicals which diminish the corrosivity of the sample to the copper strip. Therefore, the addition of such compounds for the sole purpose of biasing the test method is prohibited.

3/ Based on the gross calorific value and calculated for 0° C.
The Wobbe Index is the ratio of the calorific value of a gas per unit volume and the square root of its relative density under the same reference conditions:

$$Wobbe \cdot Index = H_{gas} \frac{p_{air}}{p_{gas}}$$

with H_{gas} = calorific value of the fuel in MJ/m³ at 0° C
P_{air} = density of air at 0° C
p_{gas} = density of fuel at 0° C

The Wobbe Index is said to be gross or net according to whether the calorific value uses is the gross or net calorific value.

2. Technical data of NG reference fuels

		G20	G23	G25
Composition:	Units:			
CH_4	% Vol	100	92.5	86
N_2	% Vol	0	7.5	14
Wobbe Index 3/	MJ/m^3	53.6 ± 2%	48.2 t 2%	43.9 ± 2%

The constituting gases of the mixtures shall have at least the following purities:

N_2: 99%
CH_4: 95% with a total content of hydrogen, carbon monoxide and oxygen below 1% and a total content of nitrogen and carbon dioxide below 2%

3. Reference fuel for positive-ignition engines

Parameter	Unit	Limits (1)		Test Method	Publication
		Minimum	Maximum		
Research octane number	RON	95.0	-	EN 25164	1993
Motor octane number	MON	85.0	-	EN 25163	1993
Density at 15°	CN	748	762	ISO 3675	1995
Reid vapour pressure	kg/m^3	56.0	60.0	EN 12	1993
Distillation	kPa				
initial boiling point	°C	24	40	EN-ISO 3405	1988
evaporated at 100°C	% v/v	49.0	57.0	EN-ISO 3405	1988
evaporated at 150°C	% v/v	81.0	87.0	EN-ISO 3405	1988
final boiling point	°C	190	215	EN-ISO 3405	1988
Residue	%	-	2	EN-ISO 3405	1988
Hydrocarbon analysis					
olefins	% v/v	-	10	ASTM D 1319	1995
aromatics	% v/v	28.0	40.0	ASTM D 1319	1995
benzene	% v/v	-	1.0	EN 12177	1998
saturates	% v/v	-	balance	ASTM D 1319	1995
Carbon/hydrogen ratio	% v/v	report	report		
Oxidation stability 2/	min	480	-	EN-ISO 7536	1996
Oxygen content	% m/m	-	2.4	EN 1601	1997
Existent gum	mg/ml	-	0.04	EN-ISO 6246	1997
Sulphur content	mg/kg	-	100	EN-ISO	1998
Copper corrosion at 50°C		-	1	14596	1995
Lead content	g/l	-	0.005	EN-ISO 2160	1996
Phosphorus content	g/l	-	0.0013	EN 237	1994
				ASTM D 3231	

4. Reference fuel for compression-ignition engines 1/

	Limits and units (2)	Test method
Cetane number(4)	minimum 45(7)maximum 50	ISO 5165
Density at 15 °C	minimum 835 kg/m^3 maximum 845 kg/m^3(10)	ISO 3675, ASTM D 4052
Distillation (3) - 95 % point	Maximum 370 °C	ISO 3405
Viscosity at 40 °C	Minimum 2.5 mm^2/s Maximum 3.5 mm^2/s	ISO 3104
Sulphur content	Minimum 0.1% mass (9) Maximum 0.2% mass (8)	ISO 8754, EN 24260
Flash point	Minimum 55°C	ISO 2719
CFPP	Minimum – Maximum + 5°C	EN 116
Copper corrosion	Maximum 1	ISO 2160
Conradson carbon residue (10% DR)	Maximum 0.3 % mass	ISO 10370
Ash content	Maximum 0.01% mass	ASTM D 482 (12)
Water content	Maximum 0.05% mass	ASTM D 95, D 1744
Neutralization(strong acid) number	Minimum 0.20 mg KOH/g	
Oxidation stability (5)	Maximum 2.5 mg/100 ml	ASTM D 2274
Additives (6)		

Note (1): If it is required to calculate thermal efficiency of an engine or vehicle, the calorific value of the fuel can be calculated from:

Specific energy (calorific value) (net) MJ/kg =

$$= (46.423 - 8.792 \times d^2 + 3.17 \times d) \times (1 - (x + y + s)) + 9.42 \times s - 2.499 \times x$$

where:

d = is the density at 288 K (15 °C)

x = is the proportion by mass of water (%/100)

y = is the proportion by mass of ash (%/100)

s = is the proportion by mass of sulphur (%/100).

Note (2): The values quoted in the specification are 'true values'. In establishment of their limit values the terms of ASTMD 3244 'Defining a basis for petroleum produce quality disputes' have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of fuel should nevertheless aim at a zero value where the stipulated maximum value is 2R and the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ASTM D 3244 should be applied.

Note (3): The figures quoted show the evaporated quantities (percentage recovered + percentage loss).

Note (4): The range of cetane is not in accordance with the requirement of a minimum range of 4R. However, in cases of dispute between fuel supplier and fuel user, the terms in ASTM D 3244 can be used to resolve such disputes provided replicate measurements, of sufficient number to achieve the necessary precision, are made in preference to single determinations.

Note (5): Even though oxidation stability is controlled, it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life.

Note (6): This fuel should be based straight run and cracked hydrocarbon distillate components only; desulphurization is allowed. It must not contain any metallic additives or cetane improver additives.

Note (7): Lower values are permitted, in which case the cetane number of the reference fuel used is to be reported.

Note (8): Higher values are permitted, in which case the sulphur content of the reference fuel used is to be reported.

Note (9): To be kept under constant review in the light of trends in the markets. For the purpose of the initial approval of an engine with no exhaust gas after treatment on request of the applicant a 0.050 % mass sulphur minimum is permissible, in which case the measured particulate level must be corrected upward to the average value that is nominally specified for fuel sulphur content (0.150 % mass) per the equation below:

$$PT_{adj} = PT + [SFC \times 0.0917 \times (NSLF - FSF)]$$

where:

PT_{adj} = adjusted PT value (g/kWh)

PT = measured weighted specific emission value for particulate emission (g/kWh)

SFC = weighted specific fuel consumption (g/kWh) calculated according to the formula as below

NSLF = average of the nominal specification of sulphur content mass fraction (i.e. 0.15 %/100)

FSF = fuel sulphur content mass fraction (%/100)

Equation for the calculation of the weighted specific fuel consumption:

$$SFC = \frac{\sum_{i=1}^{n} G_{FUEL,i} * WF_i}{\sum_{i=1}^{n} P_i * WF_i}$$

where:

$P_i = P_{m,i} + P_{AE,i}$

For the purpose of conformity of production assessments in accordance with paragraph 6. the requirements must be met using reference fuel with a sulphur content which complies with the minimum/maximum level of 0.1/0.2 per cent mass.

Note (10): Higher values are permitted up to 855 kg/m^3, in which case the density of the reference fuel used is to be reported. For the purpose of conformity of production assessments in accordance with paragraph 6, the requirements must be met using reference fuel which complies with the minimum/maximum level of 835/845 kg/m^3.

Note (11): All fuel characteristics and limit values are to be kept under review in light of trends in the markets.

Note (12): To be replaced by EN/ISO 6245 with effect of the date of implementation.

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